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Research Article

Systematic composition, species diversity and plant chorology of Wadi Shuwaib: A typical desert wadi in the eastern region of United Arab Emirates (UAE)

Sabitha Sakkir‡, Maher Kabshawi‡, Nuri Asmita‡, Salama Almansoori‡, Hassan Alahbabi‡

‡ Environment Agency - Abu Dhabi, Abu Dhabi, United Arab Emirates

Corresponding author: Sabitha Sakkir (ssakkir@ead.gov.ae)

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Abstract

The study analyses the floristic diversity, life span, life form and phytogeographic affinities of the flora of Wadi Shuwaib, a desert wadi in the eastern region of the United Arab Emirates. A total of 123 species of vascular plants were recorded belonging to 95 genera and 35 families. The most represented families were Fabaceae, Asteraceae, Poaceae and Brassicaceae. Eleven families were represented by a single species each and 77 (81.9 %) genera were monotypic. Eight species have been recorded for the first time in Abu Dhabi Emirate and represent 1.8% increase in the flora of Abu Dhabi. The recorded flora consists of 50.40% perennials and 49.59% annuals. Therophytes and Chamaephytes were the most frequent lifeforms. Phytogeographical analysis revealed that the biregional elements of the Saharo-Arabian/Sudano-Zambezian chorotype are the most dominant chorotypes (22.76%), forming approximately one fourth of the floristic structure in Wadi Shuwaib. The new additions to the local flora of the region indicate that the Wadi Shuwaib Region and the country need further thorough botanical exploration and documentation which would help in adding new species to the flora of UAE.

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Keywords

angiosperms, wadis and mountains, flora, lifeform, new records, threatened species

Introduction

The United Arab Emirates (UAE), which occupies an area of about 83,600 km^2 is characterised by different ecosystems and diversity of plant species. The recently published report recognises a total of 598 native plant species for UAE (Allen 2021). UAE's mountain regions occupy less than 5% of its surface area and are home to more than 50% of its native plants (Feulner 2023). In the UAE, the mountain ecosystem, mainly the Hajar Mountain occupies Fujairah Emirate, Ras Al Khaimah, parts of Sharjah, Dubai and Ajman enclaves of Hatta and Masfut, respectively (Feulner 2011, Feulner 2023). Jabal Hafit, the foreland ridge of the Hajar Mountains is in the Al Ain Region of the Abu Dhabi Emirate and support the highest species diversity (Sakkir and Brown 2014) in the Abu Dhabi Emirate.

The UAE is characterised by a hot and dry climate throughout most of the year and is classified as hyper-arid area according to the UNEP classification of drylands (Middleton and Thomas 1997). Despite its aridity, the UAE has a relatively rich flora, especially in regions that retain some moisture during the precipitation months, including some microhabitats of mountainous regions, wadis and silt pans in front of dams (Mahmoud 2018).

Mountains and wadis are a heterogeneous ecosystem characterised by cooler temperatures and more humid microhabitats than other ecosystems from Abu Dhabi Emirate (Javed 2023). Wadis (the Arabic term referring to a valley) are unique intrazonal landscapes in arid and semi-arid regions of the world and represent one of the most prominent desert landforms, which exhibits physiographic irregularities that lead to parallel variations in distribution of plant species (Kassas and Girgis 1964). As these wadis are drainage systems to collect water from the nearby mountains, the vegetation in these wadis is richer when compared to other desert ecosystems. Vegetation of the wadis can usually be destroyed by two factors, such as torrents and grazing. The influence of torrents on plants is partly mechanical, destroying and uprooting the plants and partly erosive removing the soil (Kassas and Girgis 1964). The wadi vegetation is also subjected to grazing and grasses like *Panicum antidotale* Retz. and woody trees like *Prosopis cineraria* (L.) Druce are liable to be cut as a source as fodder.

The wadis of the UAE exhibit significant floristic diversity, characterised by a unique assemblage of plant species adapted to the arid environment. Studies conducted over the years, including those by Brown and Sakkir 2004, El-Keblawy et al. 2016 and Mahmoud 2018 have highlighted the ecological significance of these ecosystems. The rich vegetation found in wadis supports a range of endemic and native species, contributing to biodiversity conservation in the region. The establishment, growth, regeneration and distribution of the plant communities in the wadis are controlled by

many factors, such as geographical position, physiographic features and human impacts (Shaltout and El-Sheikh 2002, Kürschner and Neef 2011, Alatar et al. 2012).

The aim of this manuscript is to analyse the vegetation of Wadi Shuwaib in terms of the floristic composition, lifeform and chorotype which, in turn, help to assess the floristic wealth of the region and understanding the basic aspects of biology such as speciation, isolation, endemism and evolution. There are no earlier reports on the flora of Wadi Shuwaib, which leads us to recognise that more floristic work is needed to fill the gaps in our understanding of the flora. The present study aims to identify and document the floristic diversity, life span, lifeforms and phytogeographic relationships and present a checklist of the flora of the wadi and thereby updating the checklist of the flora of Abu Dhabi Emirate and the UAE.

Materials and Methods

Study area

Wadi Shuwaib is located on the eastern part of the United Arab Emirates, in the Abu Dhabi Emirate, specifically in the Al Ain Region, which borders the Sultanate of Oman. It is situated on the Hajar Mountains, the largest mountain range that stretches across the borders between UAE and Oman. A dam was built to store the runoff rainwater from the surrounding mountain. The surrounding mountains receive significant rainfall during the winter months which collects in the wadis. The scope of the study was confined to the section of the Wadi Shuwaib within the UAE while a significant portion of the wadi lies within the region of Oman. (Fig. 1).

The UAE's Mountain regions receive mean annual rainfall of 160–190 mm and are, therefore, routinely classified as arid overall, although not hyper-arid (Feulner 2024). The study area is situated on the eastern part of the UAE. January is the coldest month with the lowest average temperature (13.7°C) and the hottest month is July with the highest average temperature of 44.2°C. The maximum rainfall (28.8 mm) was estimated during the month of March and the minimum of 0.3 mm during May (Fig. 2). (National Centre for Meteorology, Al Shuwaib weather station, Elevation: 292 m, Latitude: 24° 46'41'' N, Longitude: 55°47'58'' E).

Plant collection and Taxonomic identification

The species checklist presented in this study is the result of a floristic survey conducted during a period of 2023–2024. The field attributes were collected using an iPad-based IOS Collector App, which directly syncs with the plant database of the Environment Agency – Abu Dhabi (EAD). The dataset of all the records collected for the present work was deposited in a common data repository (Sakkir 2025). Plant specimens were collected and identified and named according to Jongbloed (2003). Plant lifeforms along with the life span were determined (Raunkiaer 1934) and phytogeographical affinities of

the surveyed species were defined (Agnew and Zohary 1974). Specimens were dried and deposited in the Herbarium of EAD.

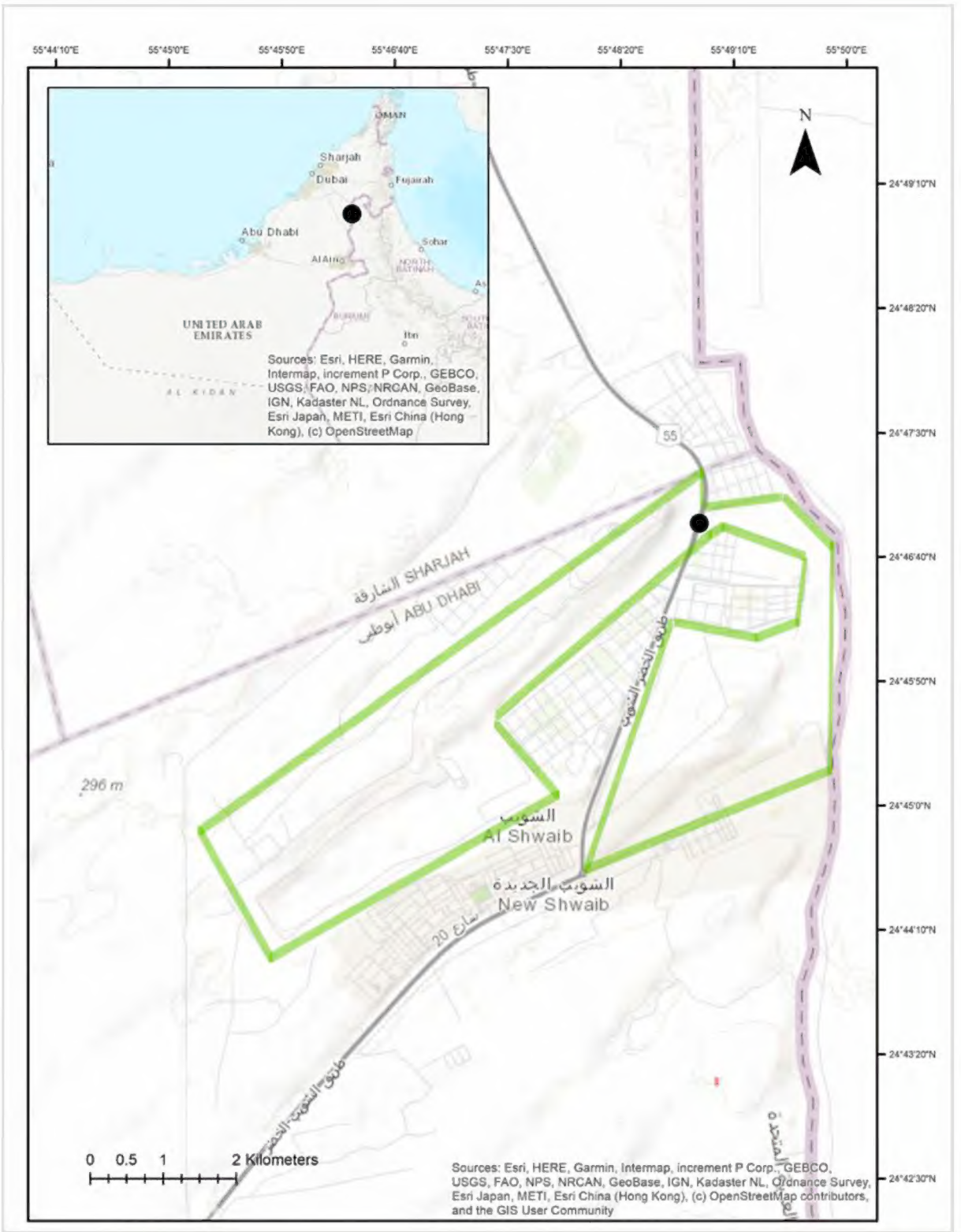


Figure 1. doi

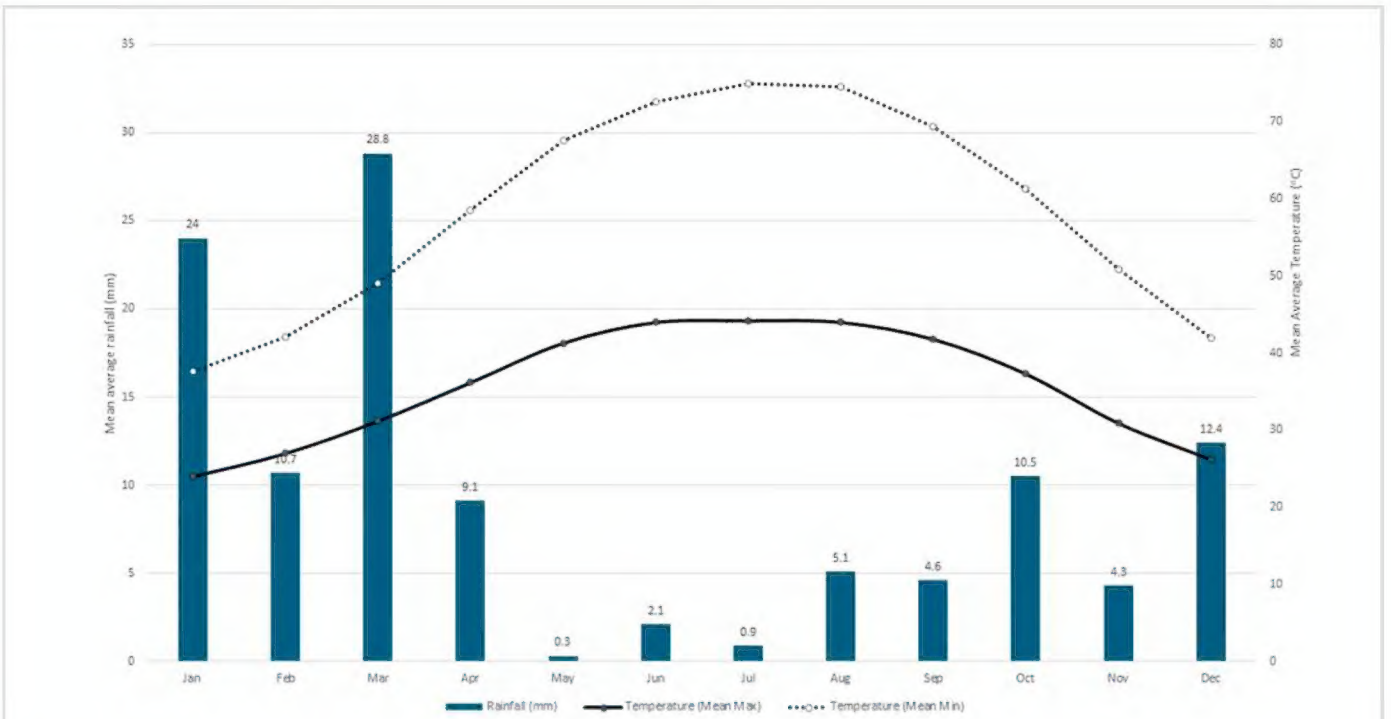
Location map of the study area (inset map of the UAE).

Results

Floristic composition

A total of 123 taxa of vascular plants were recorded from the study area, belonging to 95 genera and 35 families. Amongst them, eight species have been recorded for the first time in Abu Dhabi Emirate and represent new additions to the flora of Abu Dhabi

(Appendix 1). Four species fall under the threatened category, of which *Volutaria sinaica* (DC.) Wagenitz listed as threatened in the UAE National Red List of species, while *Vachellia tortilis* (Forssk.) Galasso & Banfi, *Prosopis cineraria* (L.) Druce and *Lycium shawii* Roem. and Schult were listed as threatened in Abu Dhabi Red List of species (Javed et al. 2020). The alien taxa *Verbesina encelioides* (Cav.) A.Gray, which is an annual and grows primarily in the temperate biome (Royal Botanic Gardens, Kew 2025) was also recorded for the first time in Abu Dhabi Emirate.



Classification: Confidential - سري

Figure 2. doi

Temperature (°C) at Shuwaib Weather station during 2022-2024. Sources: https://www.ncm.gov.ae/services/climate-reports-yearly?lang=en.

All the species recorded were Angiosperms, of which 33 families (94.28%) were dicotyledons with 109 taxa (88.61%), while monocotyledons were represented by two families, Asphodelaceae with a single taxon, *Asphodelus tenuifolius* Cav. and Poaceae with 13 (10.56%) taxa.

The most species rich families were Fabaceae (14 species = 11.38%), Asteraceae (13 species = 10.56%), Poaceae (13 species = 10.56%) and Brassicaceae (11 species = 8.94%). Amaranthaceae, Boraginaceae and Zygophyllaceae were represented by six species (4.87%) each, while Malvaceae and Cleomaceae were represented by four species each (3.25%). The families Aizoaceae, Apocynaceae, Caryophyllaceae, Plantaginaceae and Resedaceae were represented by three species each (2.43%). Ten families were represented by two species and 11 families were represented by a single species. The largest families in terms of the number of genera were Fabaceae (12 genera), Brassicaceae (11 genera), Poaceae (10) genera and Asteraceae (10 genera) (Fig. 3).

The genera with largest number of species were *Cleome* L., *Heliotropium* Tourn. ex L., *Tribulus* L. and *Launaea* Cass. with four species each, followed by *Cenchrus* L. and

Plantago L. with three species each. Twelve genera were represented by two species each, while 77 genera were represented by a single species. According to the lifeform, the perennials were represented by 62 species (50.40%) and annuals were represented by 61 species (49.59%) (Table 2).

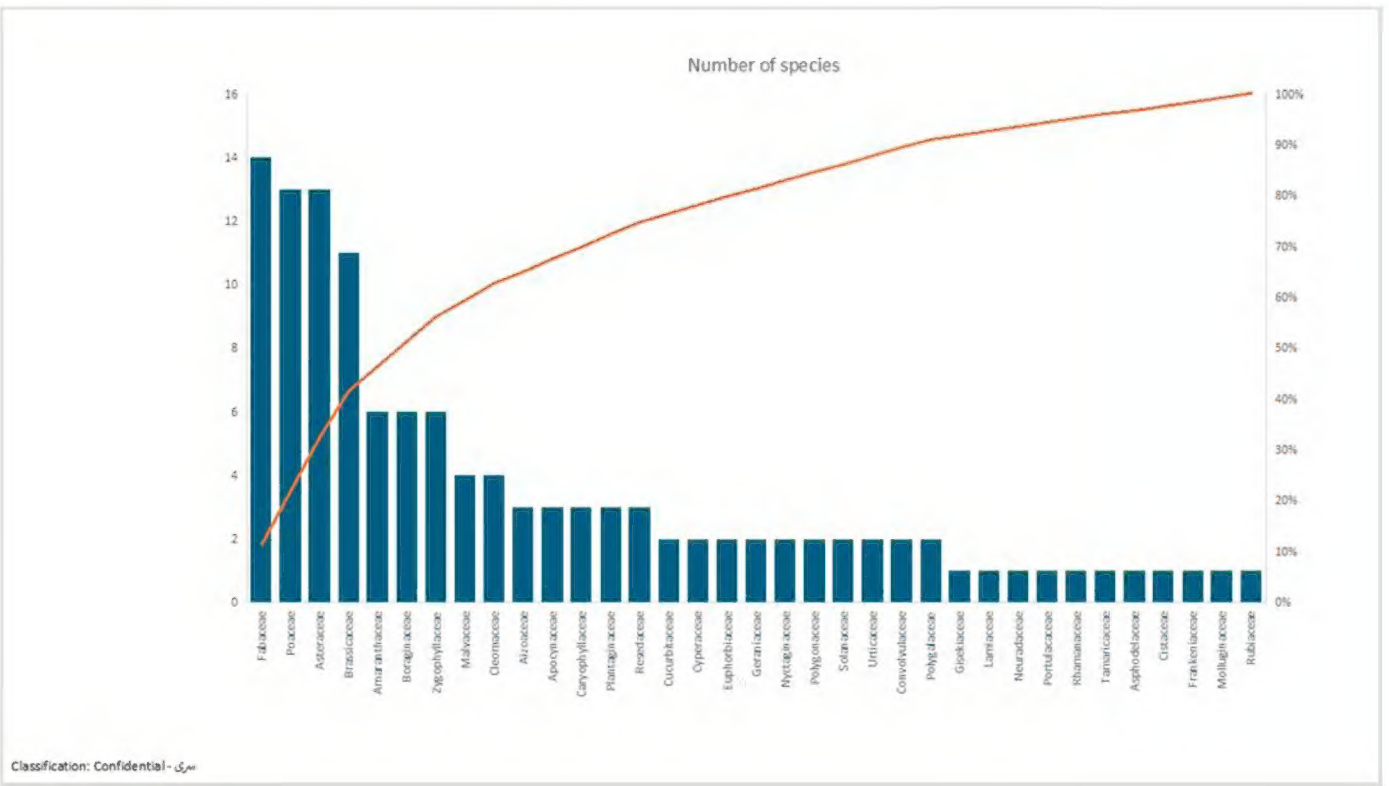


Figure 3. doi

Histogram of the floristic composition of the 29 families recorded in Wadi Shuwaib.

Table 1.

Number of plant species belonging to the main floristic chorotype and their relevant percentage recorded in Wadi Shuwaib.

Chorotypes abbreviations: ME: Mediterranean, NEO: Neotropical, PAL: Palaeotropical, PAN: Pantropical, IR-TR: Irano-Turanian, SA-AR: Saharo-Arabian, SA-SI: Saharo-Sindian, SU-ZA: Sudano-Zambezian.

Chorotype	**Number of species**	**Percentage (%) of flora**
Cosmopolitan	6	4.88
Neotropical	1	0.81
Palaeotropical	2	1.63
Pantropical	3	2.44
Total	12	9.76
Monoregional		
SA-AR	17	13.82
SA-SI	3	2.44
SU-ZA	4	3.25
IR-TR	2	1.63

Chorotype	Number of species	Percentage (%) of flora
Total	26	21.14
Biregional		
SA-AR+SU-ZA	28	22.76
IR-TR+SA-SI	4	3.25
IR-TR+SA-AR	4	3.25
SA-SI + SU-ZA	4	3.25
ME+SA-AR	4	3.25
IR-TR+ME	3	2.44
ME + SA-SI	1	0.81
ME+SU-ZA	1	0.81
Total	49	39.84
Pluriregional		
IR-TR + SA-AR + SU-ZA	13	10.57
IR-TR + ME + SA-AR + SU-ZA	4	3.25
IR-TR + ME + SA-SI +SU-ZA	4	3.25
IR-TR + ME + SA-SI	4	3.25
IR-TR + ME + SA-AR	2	1.63
IR-TR + SA-SI + SU-ZA	2	1.63
ME+SA-AR+SU-ZA	2	1.63
IR-TR+ME+TR	2	1.63
ME + SA-SI + SU-ZA	1	0.81
Total	34	17.07

Table 2.

Checklist of plant species recorded in Wadi Shuwaib along with their families, life span, lifeform and chorotypes.* New records for Abu Dhabi Emirate.

Family	Taxa	Life form	Life span	Chorotype
Aizoaceae	*Aizoon canariense* L.	He	Ann	SU-ZA
	Sesuvium verrucosum Raf.	He	Per	SA-AR+SU-ZA
	Zaleya pentandra (L.) C.Jeffrey	Th	Per	IR-TR + SA-AR + SU-ZA
Amaranthaceae	*Aerva javanica* Juss.	Ch	Ann	SA-AR+SU-ZA
	Amaranthus graecizans L.	Th	Ann	PAL
	Amaranthus viridis L.	Th	Ann	COSM
	Bassia eriophora (Schrad.) Asch.	Ch	Per	IR-TR + SA-AR + SU-ZA
	Caroxylon imbricatum (Forssk.) Moq.	Ch	Per	SA-AR+SU-ZA
	Haloxylon salicornicum (Moq.) Bunge ex Boiss.	Ch	Per	IR-TR + SA-AR + SU-ZA

Family	Taxa	Life form	Life span	Chorotype
Apocynaceae	*Calotropis procera* (Aiton) Dryand.	Ph	Per	SA-AR+SU-ZA
	Leptadenia pyrotechnica (Forssk.) Decne.	Ch	Per	SA-AR+SU-ZA
	Pergularia tomentosa L.	Ch	Per	SA-AR+SU-ZA
Asphodelaceae	*Asphodelus tenuifolius* Cav.	Th	Ann	ME+SA-AR
Asteraceae	*Atractylis carduus* (Forssk.) C.Chr.	Th	Per	ME
	Centaurea pseudosinaica Czerep.	Th	Ann	IR-TR
	Echinops erinaceus Kit Tan	Ch	Per	SA-SI
	Launaea capitata (Spreng.) Dandy	Th	Ann	SA-AR
	**Launaea massauensis* (Fres.) Chiov.	Th	Ann	IR-TR + ME + SA-AR + SU-ZA
	Launaea mucronata Muschl.	Th	Ann	IR-TR + SA-SI
	Launaea nudicaulis (L.) Hook.f.	Ch	Ann	IR-TR + SA-SI + SU-ZA
	Pluchea dioscoridis (L.) DC.	Ch	Per	SA-AR+SU-ZA
	Reichardia tingitana (L.) Pau	Th	Ann	IR-TR + ME + SA-AR + SU-ZA
	Senecio flavus (Decne.) Sch.Bip.	Th	Ann	IR-TR + ME + SA-SI
	Sonchus oleraceus L.	Th	Ann	COSM
	**Verbesina encelioides* (Cav.) A.Gray	Th	Ann	NEO
	**Volutaria sinaica* (DC.) Wagenitz	Th	Ann	SA-AR+SU-ZA
Boraginaceae	*Arnebia hispidissima* (Lehm.) A.DC.	Th	Ann	IR-TR + SA-AR + SU-ZA
	Heliotropium bacciferum Forssk.	Ch	Per	IR-TR + SA-AR + SU-ZA
	Heliotropium calcareum Stocks	Ch	Per	IR-TR+SA-AR
	Heliotropium curassavicum L.	Th	Per	TR
	Heliotropium digynum (Forssk.) Asch. ex C.Chr.	Ch	Per	SA-AR
	Trichodesma africanum (L.) Sm.	Ch	Per	SA-AR+SU-ZA
Brassicaceae	*Anastatica hierochuntica* L.	Th	Ann	SA-AR
	Diplotaxis harra Boiss.	Th	Ann	SA-AR
	Eremobium aegyptiacum (Spreng.) Asch. ex Boiss.	Th	Ann	SA-AR
	Eruca sativa Mill.	Th	Ann	IR-TR + ME + SA-AR
	Erucaria hispanica Druce	Th	Per	ME + SA-SI
	Farsetia linearis Decne. ex Boiss.	Th	Per	SA-AR+SU-ZA
	Morettia parviflora Boiss.	Ch	Per	SA-AR+SU-ZA
	Notoceras bicorne Amo	Th	Ann	SA-AR+SU-ZA
	Physorhynchus chamaerapistrum Boiss.	Ch	Ann	IR-TR + SA-AR + SU-ZA
	Savignya parviflora Webb.	Th	Ann	SA-AR
	Sisymbrium irio L.	Th	Ann	ME + SA-SI + SU-ZA

Family	Taxa	Life form	Life span	Chorotype
Caryophyllaceae	*Gymnocarpos sclerocephalus* (Decne.) Dahlgren & Thulin	Ch	Per	SA-AR
	Paronychia arabica (L.) DC.	He	Ann	IR-TR
	**Polycarpaea robbairea* (Kuntze) Greuter & Burdet	He	Ann	SA-AR+SU-ZA
Cistaceae	*Helianthemum lippii* (L.) Dum.Cours.	Ch	Per	SA-SI + SU-ZA
Cleomaceae	*Cleome amblyocarpa* Barratte & Murb.	Th	Ann	IR-TR + SA-AR + SU-ZA
	Cleome pallida Kotschy	Ch	Per	SA-AR+SU-ZA
	*Cleome rupicola*Vicary	Ch	Per	SA-AR
	Cleome scaposa DC.	Th	Ann	IR-TR + SA-AR + SU-ZA
Convolvulaceae	*Convovulus prostratus* Forssk.	Ch	Per	SA-AR+SU-ZA
	Convolvulus virgatus Boiss.	Ch	Per	IR-TR + SA-SI
Cucurbitaceae	*Cucumis prophetarum* L.	He	Per	IR-TR + ME + SA-SI +SU-ZA
Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	He	Per	IR-TR + ME + SA-SI +SU-ZA
Cyperaceae	*Cyperus conglomeratus* Rottb.	Ge	Per	SA-AR
	Cyperus rotundus L.	Ge	Per	COSM
Euphorbiaceae	*Chrozophora oblongifolia* (Delile) Spreng.	Ch	Per	SA-SI + SU-ZA
	Euphorbia prostrata Aiton	Th	Ann	IR-TR + SA-SI + SU-ZA
Fabaceae	*Argyrolobium roseum* (Cambess.) Jaub. & Spach	He	Ann	SA-SI + SU-ZA
	Astragalus eremophilus Boiss	Th	Ann	IR-TR + ME + SA-AR
	Astragalus vogelii subsp. *fatimensis* Maire	Th	Ann	SA-AR
	Crotalaria aegyptiaca Benth.	Ch	Per	IR-TR + SA-AR + SU-ZA
	Hippocrepis constricta Kunze	Th	Ann	ME+SA-AR
	Indigofera arabica Burm.f.	Ch	Per	SU-ZA
	Medicago sativa L.	Th	Ann	IR-TR+SA-AR
	Prosopis cineraria (L.) Druce	Ph	Per	SA-SI
	Rhynchosia minima (L.) DC.	Ch	Per	SA-AR
	Senna italica Mill.	Ch	Per	IR-TR + ME + SA-SI +SU-ZA
	Taverniera glabra Boiss.	Ch	Per	IR-TR + SA-AR
	Tephrosia purpurea subsp. *apollinea* (Delile) Hosni & El-Karemy	Ch	Per	SU-ZA
	Tephrosia nubica (Boiss.) Baker	Ch	Per	SA-AR+SU-ZA
	Vachellia tortilis (Forssk.) Galasso & Banfi	Ph	Per	IR-TR + ME + SA-AR + SU-ZA

Family	Taxa	Life form	Life span	Chorotype
Frankeniaceae	*Frankenia pulverulenta* L.	Th	Ann	IR-TR+ME
Geraniaceae	*Monsonia heliotropoides* Boiss.	Ch	Per	SA-AR+SU-ZA
	Monsonia nivea Webb	Ch	Per	SA-AR+SU-ZA
Gisekiaceae	*Gisekia pharnaceoides* L.	Th	Ann	PAL
Lamiaceae	**Salvia macrosiphon* Boiss.	Th	Ann	IR-TR+ME
Malvaceae	*Corchorus depressus* (L.) Stocks	Th	Per	ME+SA-AR
	Corchorus trilocularis L.	Th	Ann	TR
	Hibiscus micranthus L.f.	Th	Ann	SA-AR+SU-ZA
	Malva parviflora L.	Th	Ann	IR-TR + ME + SA-SI
Molluginaceae	**Glinus lotoides* L.	Th	Ann	IR-TR+ME+TR
Neuradaceae	*Neurada procumbens* L.	Th	Ann	COSM
Nyctaginaceae	*Boerhavia diffusa* L.	Ch	Per	COSM
	**Boerhavia elegans subsp. stenophylla* (Boiss.) A.G.Mill.	Th	Ann	SA-SI
Plantaginaceae	*Plantago amplexicaulis* Cav.	Th	Ann	IR-TR + ME + SA-SI
	Plantago afra L.	Th	Ann	IR-TR + ME + SA-SI
	Plantago ciliata Desf.	Th	Ann	IR-TR + SA-AR + SU-ZA
Poaceae	*Aristida adscensionis* L.	Th	Ann	IR-TR + SA-AR + SU-ZA
	Cenchrus ciliaris L.	He	Per	SA-AR+SU-ZA
	Cenchrus divisus (J.F.Gmel.) Verloove, Govaerts & Buttler	He	Per	SA-AR
	Cenchrus sieberianus (Schltdl.) Verloove	He	Ann	SA-AR
	Echinochloa colonum (L.) Link	Th	Per	IR-TR+ME+TR
	Panicum antidotale Retz.	He	Per	SA-AR+SU-ZA
	Stipagrostis plumosa (L.) Munro ex T.Anderson	He	Per	IR-TR + SA-AR + SU-ZA
	Centropodia forskaolii (Vahl) Cope	He	Ann	IR-TR+SA-AR
	Cynodon dactylon (L.) Pers.	Th	Per	PAN
	Panicum turgidum Forssk.	He	Per	SA-AR+SU-ZA
	Tragus berteronianus Schult.	Th	Ann	SA-AR+SU-ZA
	Tragus racemosus (L.) All.	Th	Ann	SA-AR+SU-ZA
	Tripidium ravennae (L.) H.Scholz	Ge	Per	SA-AR+SU-ZA
	Polygala erioptera DC.	Ch	Ann	SA-AR
Polygalaceae	*Polygala irregularis* Boiss.	Ch	Ann	SA-SI + SU-ZA
Polygonaceae	*Emex spinosus* L.	Th	Ann	PAN
	Rumex vesicarius L.	Th	Ann	ME+SA-AR+SU-ZA
Portulacaceae	*Portulaca oleracea* L.	Th	Ann	COSM

Family	Taxa	Life form	Life span	Chorotype
Resedaceae	*Ochradenus arabicus* Chaudhary, Hillc. & A.G.Mill.	Ch	Per	SA-AR
	Oligomeris linifolia (Vahl ex Hornem.) J.F.Macbr.	Ann	Th	IR-TR+ME
	Reseda aucheri Boiss.	Th	Per	IR-TR + SA-SI
Rhamanaceae	*Ziziphus spina-christi* (L.) Desf.	Ph	Per	IR-TR + ME + SA-AR + SU-ZA
Rubiaceae	*Kohautia caespitosa* Schnizl.	Th	Ann	SU-ZA
Solanaceae	*Lycium shawii* Roem. & Schult.	Ph	Per	IR-TR + SA-AR + SU-ZA
	Solanum nigrum L	Ch	Per	SA-AR+SU-ZA
Tamaricaceae	*Tamarix* sp.	Ph	Per	ME+SA-AR+SU-ZA
Urticaceae	*Forsskaolea tenacissima* L.	Ch	Per	IR-TR + ME + SA-SI +SU-ZA
	**Forsskaolea viridis* Ehrenb. ex Webb	Th	Ann	SA-AR+SU-ZA
Zygophyllaceae	*Tribulus arabicus* Hosni	He	Per	SA-AR
	Tribulus macropterus Boiss.	He	Per	IR-TR + SA-SI
	Tribulus pentandrus Forssk.	He	Per	PAN
	Tribulus terrestris L.	Th	Ann	ME+SU-ZA
	Zygophyllum indicum (Burm.f.) Christenh. & Byng	Ch	Per	SA-AR
	Zygophyllum simplex L.	Th	Ann	SA-AR+SU-ZA

Lifeform spectra

The studied flora falls under five major lifeforms. Therophytes were the most frequent lifeforms (59 species = 47.97%) followed by Chamaephytes (38 species = 30.89%), Hemicryptophytes (17 species = 13.82%), Phanerophytes (6 species = 4.88%) and Geophytes (3 species = 2.44%) (Table 2, Fig. 4).

Chorological affinities

Chorological analysis of the 123 plant species recorded in this study has been classified into three major phytogeographical groups: monoregional, biregional and pluriregional.

A total of 26 species representing 21.14% of the total number of recorded species were monoregional taxa of different affinities. The monoregional elements fall under four main chorotypes: Saharo-Arabian taxa (17 species forming 13.82% of recorded species), Sudano-Zambezian taxa (4 species forming 3.25% of recorded species) and Saharo-Sindian taxa (3 species forming 2.44% of recorded species). Two Irano-Turanian taxa were recorded in the study area (*Centaurea pseudosinaica* Czerep and *Paronychia arabica* (L.) DC.) representing 1.63% of the surveyed flora.

The biregional elements has the highest representation (49 species = 39.84%) with different affinities. The biregionals falls under eight main chorotypes: the Saharo-Arabian / Sudano-Zambezian chorotypes together have the highest number of species (28 species) representing 22.76% of the total flora, followed by the Irano-Turanian / Saharo-Arabian, Irano-Turanian / Saharo-Sindian, Saharo-Sindian / Sudano-Zambezian and Mediterranean / Saharo-Arabian Region represented by four species each (3.35%). The Irano-Turanian / Mediterranean Region and were represented by three species (2.44%). The lowest number of species was recorded for the Mediterranean/Saharo-Sindian (*Erucaria hispanica* Druce) Mediterranean/ Sudano-Zambezian (*Tribulus terrestris* L.) represented by a single species each.

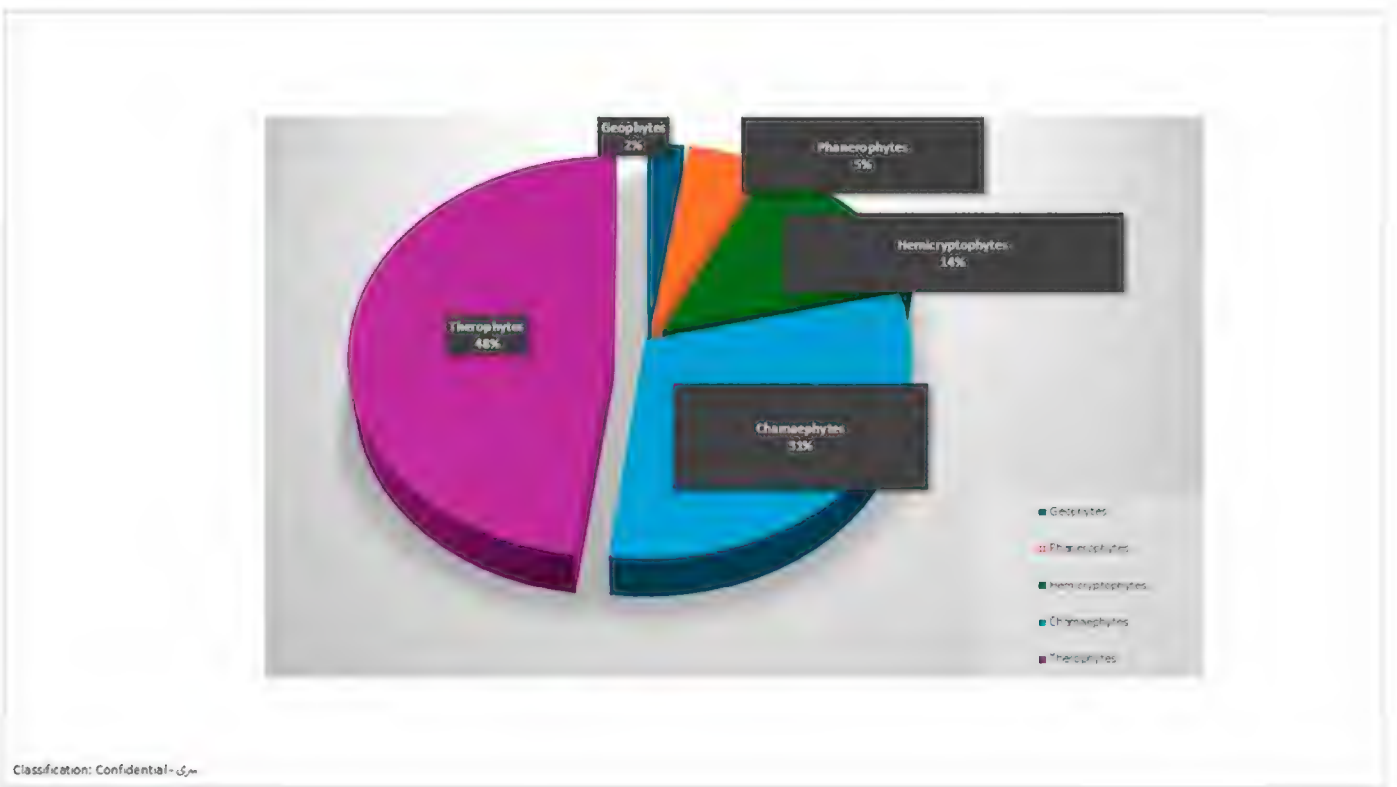


Figure 4. doi

Lifeform spectra of the plant species recorded from Wadi Shuwaib.

The pluriregional elements were represented by a total of 34 species (17.07%) of different affinities. The pluriregional elements falls under nine different chorotypes: Irano-Turanian / Saharo-Arabian / Sudano-Zambezian (13 species forming 10.57% of recorded species) has the highest number of species in the pluriregional chorotype. The Irano-Turanian / Mediterranean / Saharo-Sindian / Sudano-Zambezian, Irano-Turanian / Mediterranean / Saharo-Sindian / Sudano-Zambezian and Irano-Turanian / Mediterranean / Saharo-Sindian were represented by four species each (3.25%). Irano-Turanian / Mediterranean / Saharo-Arabian, Irano-Turanian / Saharo-Sindian / Sudano-Zambezian, Mediterranean / Saharo-Arabian / Sudano-Zambezian and Irano-Turanian / Mediterranean / Tropical Region were represented by two species each (1.63%), while Mediterranean / Saharo-Sindian / Sudano-Zambezian were represented by a single species (*Sisymbrium irio* L.). The remaining 12 species were distributed amongst Cosmopolitan (6 species = 4.88%), Pantropical (3 species = 2.44%), Palaeotropical (2 species = 1.63%) and Neotropical (1 species = 0.81%) chorotypes. (Table 1).

Discussion

The mountain and the associated wadi ecosystems in the UAE are of great floristic and ecological importance. The present study reveals that the floristic composition of Wadi Shuwaib is highly diverse. The diversity may be due to various environmental factors which are favourable for most of the species recorded. In the current study, the floristic analysis of vascular plant species from the study area includes 123 species belonging to 95 genera and 35 families (Table 2). This is thought to be mainly due to the presence of wadi habitat where runoff water collects and provide sufficient moisture and suitable conditions for the plant growth. As water is the most limiting factor for plant growth and survival in arid regions, the wadi bed provides the most favourable conditions for plant growth, especially for plants that have greater water requirements (El-Keblawy et al. 2016). These areas are also liable to wash-outs during flash floods.

The floristic diversity of wadi ecosystems in the UAE has been extensively documented through various studies by Brown and Sakkir 2004,Mousa and Fawzi 2009,Mousa 2011, El-Keblawy et al. 2016, and Mahmoud 2018 which highlighted the floristic diversity of wadi ecosystems in the UAE. All these studies have shown that wadi vegetation is diverse and supports a range of endemic and native species, contributing to biodiversity conservation in the region. The present study conducted at Wadi Shuwaib further supports these findings, highlighting the significant floristic diversity present within this specific wadi.

The floristic survey showed that most species rich families were Fabaceae (14 species), Asteraceae (13 species), Poaceae (13 species) and Brassicaceae (11 species). These results confirmed to those of Mahmoud 2018and Brown and Feulner 2024. This can be attributed to their efficient germination strategies, seed dispersal capabilities, migration efficiency and wide ecological range of tolerance, in addition to local conditions of water availability (Brown and Feulner 2024). The present survey revealed also that only few families are floristically rich and the floristic composition of Wadi Shuwaib exhibited a high degree of monotypism, where 77 genera were represented by a single species. This may be because flora of an area, in which species are distributed amongst various genera, families or other higher ranks, exhibit greater genomic information and phylogenetic diversity than that where most species belong to the same genus or concentrated into fewer higher ranks (Khedr 2002).

The vegetation consisted of almost equal representation of the annual and perennial species. This could be due to the rainfall events which provides a better chance for the appearance of a considerable number of annuals, which have high reproductive capability and have the capacity to dominate the ecosystems, thereby giving a characteristic physiognomy to their vegetation (Shaltout 2010). Perennial plants are adapted to the extreme climatic conditions and they have different adaptations and survival strategies to cope with the harsh climatic conditions which are discussed in detail by Brown and Feulner (2024). The presence of synanthropic species such as *Bassia*

eriophora, *Cynodon dactylon* and *Tamarix* sp. indicated the presence of human impact in the area.

The UAE has no nationally endemic plant species, but seven species found in the UAE are considered endemic to the mountains of the UAE and northern Oman (Feulner 2016). *Echinops erinaceus* which is endemic to the mountains of the UAE and northern Oman was recorded from the study area. Moreover, four species recorded fall under the threatened category both locally and nationally. The presence of endemics and threatened species in the study area indicates special ecological and biogeographic importance of the area.

The distribution of lifeforms is closely related to topography and landform (Kassas and Girgis 1964, Agnew and Zohary 1974, Evenari et al. 1986, Shaltout 2010). In the present study, the composition of lifeforms expresses a typical desert flora, most species being therophytes and chamaephytes. These results agree with the spectra of vegetation in other parts of UAE (Mahmoud 2018). Therophytes are characteristic of desert climate (Malik 2007). Therefore, the dominance of therophytes in the study area may be an outcome of the harsh weather and high aridity in the region. The high percentage of chamaephytes may be related to their ability to resist to the drought, salinity and sand accumulation (Bana 2002).

According to Feulner (2011), the mountain areas of the UAE are a meeting point for floral elements from the Saharo-Arabian, Nubo-Sindhian, Irano-Turanian and Mediterranean Regions. Chorological analysis of the floristic data from the study area revealed that the biregional Saharo-Arabian/Sudano-Zambezian chorotypes together have the highest number of species, which are good indicators of a desert environment. Typical representatives of the Saharo-Arabian Region such as *Anastatica hierochuntica*, *Haloxylon salicornicum*, *Neurada procumbens*, *Savignya parviflora* and *Stipagrostis* spp. were recorded from the study area. Some of the characteristic species of Sudanian Region present in the study area includes *Acacia tortilis*, *Calotropis procera*, *Leptadenia pyrotechnica*, *Panicum turgidum*, *Pennisetum divisum* etc. The combination of different phytochoria with uneven numbers of species can be attributed to factors such as diversity of habitats, topography, water availability and the capability of certain taxa to penetrate the study area from different adjacent phytogeographical regions (Abbas et al. 2020).

The Emirate of Abu Dhabi is home to around 436 species of native plants distributed in diverse habitats (Dhaheri 2017). The present survey also found seven species that had not been recorded before in the flora of the Abu Dhabi. The presence of new records of in the wadi can be attributed to the following factors: (i) The unique geographical location of Wadi Shuwaib; (ii) its proximity to the Hajar Mountain range, which trigger most of the rainfall descending on this land; (iii) the presence of the dam; and (iv) The rich and diverse flora of the study area owing to the combination of Saharo-Arabian/Sudano-Zambezian species. There was a widespread distribution of the alien taxa, *Verbesina encelioides* in the wadis. As Wadi Shuwaib lies to the border with Oman, the major invasions of the flora of the area are due to intentional or unintentional actions of humans, animals, birds and, to some extent, due to traffic across the borders.

The combination of extreme summer temperatures, low annual rainfall and the unpredictability of rainfall poses challenges for the native flora and fauna of the UAE (Feulner 2023). Preserving the unique wadi ecosystems in the UAE is crucial due to their ecological, hydrological and cultural significance. Effective conservation strategies such as habitat protection, systematic species monitoring and infrastructure to manage flash floods can help maintain biodiversity, protect water resources and support sustainable development in such ecosystems. A total of eight species being new additions to the local flora of the region, represents a 1.8% increase on the previously published species list of Abu Dhabi Emirate.

Conclusion

The new records highlight the ongoing contributions to the botanical understanding of the Emirate and indicate the need for further botanical exploration and documentation which would help in adding species records to the local flora and to the flora of UAE. This also underscores the importance of protecting the natural ecosystems of the country.

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Conflicts of interest

The authors have declared that no competing interests exist.

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